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DOUGLAS-FIR BEETLE PROBLEMS

Dixie National Forest

By R. I. Washburn

Intermountain Region
Ogden, Utah

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DIXIE NATIONAL FOREST

FOREWORD

The analysis of the Douglas-fir bark beetle problems on the Dixie National Forest prepared by Dick Washburn was made at my request to supply forest managers with a specific example of the extent and seriousness of the losses being experienced in an important area of timberland in our Region. The report shows how large the recent losses have been and reveals that similar Douglas-fir losses have occurred in the past. What has happened in the past may happen again. Had an important share of this resource loss been prevented, and the timber harvested, thus entering commerce and trade in this country, the benefits would have been sizable.

Not all of the Douglas-fir stands are on sites or in locations that could be practicably harvested. Some of the stands are needed for watershed protection and for aesthetic or recreation purposes or located on terrain uneconomic to log. Nevertheless, had planning and construction of the transportation system for the Dixie National Forest been initiated many years ago, it is probable that an important share of the losses reported by Mr. Washburn's report could have been salvaged or prevented. This transportation system would have helped to meet the challenge posed by the infestation and at the same time would provide access for game harvest, recreation use, and for general overall management of all the resources of the Dixie National Forest.

The lesson to be learned is that history has repeated itself and is likely to be duplicated in the future on this unit as well as on other similarly situated units in Region Four. Planning for meeting this challenge in the future should take this lesson into account. We should plan more wisely in the future.

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INTRODUCTION

Without exception the Douglas-fir beetle, Dendroctonus pseudotsugae Hopk., is the most destructive bark beetle of Douglas-fir timber throughout the western United States and Canada. Epidemics of Douglas-fir beetle have occurred on the Dixie National Forest periodically for as long as records have been kept, and undoubtedly before. Mr. H. E. Burke, an early forest entomologist, found epidemic populations of the Douglas-fir beetle near Panguitch Lake and east of Panguitch, Utah, in 1907. The epidemic was thought to be about four years old at that time. No record could be found telling how long this epidemic persisted.

In 1933 the Douglas-fir beetle had again built to epidemic populations on the Dixie National Forest including the old Powell National Forest. That epidemic reached its peak about 1936. In 1936, J. A. Beal, who is now Director of the Division of Forest Insect Research, Washington Office, reported about half of the Douglas-fir on the Dixie National Forest had been recently killed by the Douglas-fir beetle. His report stated further: "The beetles have attacked young and old trees alike, and tree vigor apparently has been no protection. This is by far the most aggressive Douglas-fir beetle outbreak I have observed."

The first attempts to control this beetle took place in 1936 and 1937. Altogether the Dixie National Forest and Bryce Canyon National Park organizations treated about 2,700 trees.

In 1940, heavy kill was reported in the Strawberry Creek drainage. By 1942 a widespread agressive infestation had developed on the west side of the East Fork of the Sevier River where thousands of trees were killed each year.

Little mention of the Douglas-fir beetle is made in reports between 1942 and 1949, but there probably were many small localized infestation centers active during that period. In 1950 it was reported that most of the Douglas-fir stands on the Aquarius Plateau were infested. This infestation persisted until 1963 and epidemics developed in nearly all Douglas-fir stands on the Dixie National Forest between 1950 and 1963. Today it is nearly impossible to find even small stands of Douglas-fir on the Dixie National Forest that do not show evidence of recent extensive tree mortality caused by the Douglas-fir beetle.

This report is an effort to put together information on the Douglas-fir beetle problem on the Dixie National Forest. The objective is to provide a general picture that will be helpful to determine what, if any, action might be taken to salvage remaining stands and/or combat new outbreaks of the bark beetle.

LIFE HISTORY AND HABITS OF THE DOUGLAS-FIR BEETLE

The main attack period of this beetle begins about the middle of May and continues until the end of that month, with a few attacks occurring in early June. Upon arrival at the new host, the female beetle excavates a horizontal entrance tunnel through the bark to the cambium where she begins to tunnel a simple longitudinal egg gallery up the tree in the inner bark, grooving the wood slightly. The male beetle crawls over the bark surface searching for a mate and when she is discovered excavating an entrance hole, he will stand by and follow her into the tunnel as she progresses.

Fertilization takes place after about an inch of egg gallery has been excavated in the inner bark. After fertilization, the female continues the egg gallery and the male either continues on with this female, assisting her in the disposal of the frass, or leaves the gallery to search for another mate.

The egg galleries range from three to twenty-three inches in length and average about nine inches. Eggs are deposited along the sides of the gallery in alternate groups of from two to thirteen eggs.

The eggs are pearly-white in color, oval in shape, and average 1.19 mm. in length and .672 mm. in width. They hatch approximately fifteen days after being laid, the larvae beginning to appear early in June. The larvae construct feeding tunnels or mines at right angles to the egg galleries, about seventy days being required to complete the four larval stages. During this period of development, approximately forty percent of the larvae excavate outwards from between the bark and wood into the inner bark where they are hidden from view when the bark is removed from the tree. When the larvae have reached the last instar, they excavate a shallow pupal cell in which they transform to pupae, just before the middle of August. Pupae may be either exposed or hidden when the bark is removed, depending on whether or not the larvae left the cambium layer.

Seven or eight days are required for the pupal period to be completed. At the end of this time, the pupae shed their skins to become callow adults. These feed in the inner bark and overwinter in this stage to emerge and attack fresh hosts in May and June.

Some of the parent beetles in the May- and June-attacked trees complete their galleries and emerge from the hosts during July. They then attack another green tree and raise a second brood. This brood develops at approximately the same rate as the first, overwinters in the larval stage and emerges during July and August to attack new trees.

Newly emerged adults have an equal sex ratio; however, more females attack trees than males. It is not known what happens to males between time of emergence and attack to cause the numerical inequality of sexes found in newly attacked trees; but since some males are polygamous and after fertilizing one female, emerge and seek another mate, an unequal sex proportion is not a factor causing abnormal increases or decreases in populations.

Brood Potential

In the administration of a control project or the evaluation of an area to determine the advisability of control, it is of great importance to be able to predict the potential danger of a unit of infested material. For this reason it is essential to know the brood potential of this bark beetle.

Table 1 illustrates a typical simplified life table of the Douglas-fir beetle and shows brood potential and mortality:

Table 1.---A Typical Life Table of the Douglas-fir Beetle

Stage	Individuals Per Sq. Ft.	Decrease to Next State	Percent Mortality	Percent Total Mortality
Attacking Parents	14			
Egg	168	105	62.5	62.5
Larvae	63	31	49.2	18.5
Pupae	32	7	21.8	4.1
Callow Adult	25	7	28.0	4.1
Emerging Adults	18	Total Mortality		89.2

Many factors govern the rise and decline of epidemics. It is not possible to assess exactly the importance of the individual factors at any one time. However, the sum total of these influences is reflected in brood survival.

Consequently, brood count data are relied on almost entirely to predict the future course of outbreaks, tempered by the entomologist's interpretation of the conditions as he sees them.

CAUSES FOR RISE AND DECLINE OF EPIDEMICS

A logical and appropriate question at this point would be, "What causes the rise and decline of epidemics?" Here again, there is no pat answer and very little concrete proof for the statements presented. It is known, however, that the Douglas-fir beetle does prefer windthrown or damaged trees, and outbreaks have often developed where this type of damage has occurred. Logging slash can very well have the same effect. Examinations of Dixie infestations for the last ten years, however, show most of the stands did not have sufficient damaged or windthrown timber to give rise to the recent epidemic situation. On the other hand, most of the outbreaks

appear to have had two things in common: portions of the stands were dense, and; overcrowded conditions were present. In addition, most of these areas had suffered an apparently drastic lowering of the water table. In some instances the lower water table was probably the direct result of drought conditions and accelerated erosion. In a few cases the local water table had been affected by cutting roads around the hillsides.

The decline of this Douglas-fir beetle epidemic in 1963 was probably the result of a combination of factors which affected the host trees and the insect population directly. Little can be done to manipulate or regulate factors such as predator and parasite or climatic conditions; therefore, knowledge of their effect is useful only in the interpretation of the beetle potential.

On the other hand, population reductions may be encouraged by decreasing stand density, raising the level of the water table, and prompt elimination of windthrown and damaged material including large slash.

PRESENT CONDITIONS

To obtain the data for this report two men, one from the Dixie National Forest and the other from the Section of Detection and Evaluation, Branch of Forest Insect and Disease Prevention and Control, Division of Timber Management, Regional Office, worked as a team. Prior to their assignment all Douglas-fir beetle infestations were mapped from the air to provide a base map upon which the men could schedule their work. Major infestations were examined and data collected from one-fifth-acre plots, selected as nearly as possible in a random manner. Sufficient plots were taken from each area to provide a general and representative picture of the situation. Plot data collected included the number of Douglas-fir above 6" DBH that were green, dead, or infested. The data were separated into two broad groups, 6 to 12" DBH and 12" DBH and greater. (Tables 2 and 3) The average DBH and estimated height in number of logs was recorded for all trees above 12". Brood density data were collected from infested trees. Altogether eleven infestations were examined. The sampled infestations were scattered over three districts and, with the possible exception of that portion west of Cedar City, Utah, should be fairly representative of the Douglas-fir beetle problem on the Dixie National Forest.

Collectively, the data show that about 56 percent of all the Douglas-fir trees above 6" DBH within the infested stands are now dead. Of the stems above 12" DBH, 68 percent have been killed. The original stand density above 6" DBH averaged 75.6 stems per acre, about half of which were above 12" DBH. Recent epidemics had occurred in all areas sampled.

Obviously, forest-wide averages have little value except to reflect the impact that the Douglas-fir beetle has had on the total resource.

Douglas-fir makes up about 15 percent of the available sawtimber volume on the Dixie, and the type occupies about 12 percent of the total commercial forest acreage.

Table 2.---Average Number of Douglas-fir Trees per Acre

Unit	DBH (inches)	Green Trees	Trees Killed 1950-63	No. of Standing Trees above 6" DBH
Circleville District				
Horse Creek	6-12	13.0	5.0	18.0
	12+	10.0	29.0	39.0
				57.0
Sweetwater	6-12	36.0	16.3	52.3
	12+	8.8	23.8	32.6
				84.9
Mud Lake Road	6-12	18.0	13.0	31.0
	12+	3.0	26.0	29.0
				60.0
Pacer Lake	6-12	18.3	6.7	25.0
	12+	16.7	36.6	53.3
				78.3
Antimony Creek	6-12	61.0	12.0	73.0
	12+	2.5	21.0	23.5
				96.5
Cottonwood	6-12	18.8	21.3	40.1
	12+	1.3	21.3	22.6
				62.7
Powell District				
Hunt Creek	6-12	23.3	25.0	48.3
	12+	16,7	10.0	26.7
				75.0
Panguitch District				
Indian Hollow	6-12	20.0	25.0	45.0
	12+	3.0	19.2	22.2
				67.2
Red Creek	6-12	2.5	15.0	17.5
	12+	0	50.0	50.0
				67.5
Bear Valley	6-12	10.0	18.3	28.3
	12+	67.0	23.3	90.3
				118.6

Table 2, Continued

Unit	DBH (inches)	Green Trees	Trees Killed 1950-63	No. of Standing Trees above 6" DBH
N.S. Five Mile	6-12	10.0	36.7	46.7
	12+	1.7	15.0	16.7
				63.4
Dixie Average	6-12	21.0	17.7	38.7
	12+	11.9	25.0	36.9
		32.9	42.7	75.6

Table 3.---Percent of Douglas-fir Trees Green, Dead or Infested Per Acre

Unit	DBH (inches)	Green Trees	Trees Killed 1950-1963
Circleville District			
Horse Creek	6-12	72.2	27.8
	12+	25.6	74.3
Total			59.7
Sweetwater	6-12	68.8	31.2
	12+	27.0	73.0
Total			47.2
Mud Lake	6-12	58.1	41.9
	12+	10.4	89.6
Total			65.0
Pacer Lake	6-12	73.2	26.8
	12+	31.4	68.6
Total			55.3
Antimony Creek	6-12	83.6	16.4
	12+	10.6	89.4
Total			34.2
Cottonwood	6-12	46.9	53.1
	12+	5.8	94.2
Total			67.9
Powell District			
Hunt Creek	6-12	48.3	51.7
	12+	62.5	37.5
Total			46.7
Panguitch District			
Indian Hollow	6-12	44.4	55.6
	12+	13.5	86.5
Total			65.8
Red Creek	6-12	14.3	85.7
	12+	0	100.0
Total			96.3

Table 3, Continued

Unit	DBH (inches)	Green Trees	Trees Killed 1950-1963
Bear Valley	6-12	35.3	64.7
	12+	6.8	93.2
Total			35.1
N.S. Five Mile	6-12	21.4	78.6
	12+	10.2	89.8
Total			81.5
Dixie Totals	6-12	54.0	46.0
	12+	32.0	68.0
Totals all sizes		43.0	57.0

Tables 4 to 6 inclusive, taken from the Dixie National Forest timber management plan show a breakdown of the Douglas-fir resource by various classifications. Figures are based upon timber inventory data collected in 1956.

Table 4.---Acres of Douglas-fir by Stand Size Classes and Multiple-Use Zones 1/

	Sawtimber	Poles	Seedlings	Total
Crest	-	-	-	-
Travel	2,816	20		2,836
Water	1,445	-	-	1,445
Special	-	-	-	-
Deferred	6,257	711	-	6,968
Lower & Int.	62,180	5,594	82	67,856
TOTALS	72,698	6,325	82	79,105

1/ Total Douglas-fir acreage on unit. Includes 10,363 acres classified as nonloggable.

Table 5.---Douglas-fir Type Area and Volume MBM

	Acres	DF	PP	WF	AF	ES	Asp.	WLP	Total
Large Sawtimber Well Stocked	162	1,601							1,601
Large Sawtimber Medium Stocked	303	3,563		302	235	629	40	173	4,942
Large Sawtimber Poorly Stocked	1,785	9,647	1,667	89	681	1,306		2,392	15,782
Small Sawtimber Medium Stocked	7,870	92,544		7,854	6,099	16,331	1,053	4,501	128,382
Small Sawtimber Poorly Stocked	62,578	303,832	41,108	6,395	12,733	30,603	3,404	26,460	424,535
Pole Stand Well Stocked	133	128			41				169
Pole Stand Medium Stocked	4,679	35							35
Pole Stand Poorly Stocked	1,519								
Seedling Sapling Stand Well Stocked	82								
TOTALS	79,105 1/	411,350	42,775	14,640	19,789	48,869	4,497	33,526	575,446

1/ Includes 10,363 acres classified as nonloggable.

Douglas-Fir

Table 6.---Type Area, Volume, and Allowable Cut by Districts
M bd. ft.

District	Acres	Volume (All Species)	Allowable Cut
Pine Valley	6,988	66,719	-
Cedar City	11,177	112,052	840
Panguitch Lake	9,587	65,591	720
Powell	8,168	62,368	600
Circleville	28,815	210,316	2,230
Escalante	6,048	25,088	420
Teasdale	8,322	33,312	660
TOTALS	79,105 1/	575,446	5,470

1/ Includes 10,363 acres classified as nonloggable.

DISCUSSION

Circleville District

In the period 1950 through 1963 nearly all the Douglas-fir stands on the Circleville District contained epidemic populations of Douglas-fir beetle. Most of the infestations were active for at least five years. A good share of the stands are relatively inaccessible and occur primarily as patches of timber on steep slopes. Horse Creek, Sweetwater, Mud Lake, Pacer Lake, Antimony Creek, and Cottonwood Creek were selected as being representative of the Douglas-fir stands on this District. The infestation at the head of Horse Creek increased rapidly from 1959 through 1962. Large groups of dead and faded trees were scattered throughout the infestation and were visible from several vantage points.

The original stand density averaged 57 stems above 6" DBH per acre, but within the stand many areas were overstocked. Over 59 percent of the 57 stems per acre are now dead. Seventy-four percent of the trees of merchantable size (over 12" DBH), have been killed. Of the green trees now present in the stand a little over 56 percent are between 6" and 12" DBH. This leaves an average of only ten trees per acre above 12" DBH. These remaining trees average 16" DBH, two logs in height and contain approximately 120 bd. ft. Logging in this stand in the past was concentrated primarily in the bottom of the drainage and limited to small sales. The recent Horse Creek sale included much of the remainder of the Douglas-fir timber in this drainage. Approximately 1,300 MBM of Douglas-fir was cut by the end of 1963. Most of the volume was removed from clear-cut blocks in an effort to salvage clumps of infested and dead material.

Immediately south of Horse Creek in the Sweetwater drainage there is a large stand of Douglas-fir concentrated at the head of the drainage and along the north facing slopes. The epidemic in this drainage developed about the same time as the Horse Creek outbreak. The road to Barney Top cuts through the upper edge of this stand of timber and it is possible that the deep dugways may have contributed to the beetle buildup by diverting sub-soil moisture. The survey estimates 47 percent of the total stems above 6" DBH have been killed. Nearly three-fourths of the trees 12" DBH or above have been killed, however. The number of green trees above 6" DBH averaged 45 per acre, but only 8.8 trees per acre are larger than 12" DBH.

The scattered patches of Douglas-fir facing the Mud Lake road were under severe attack by the Douglas-fir beetle for about ten years prior to 1963. Ninety percent of the trees above 12" DBH have been killed. The green stand density was reduced from 60 trees per acre to only 21 and only about three percent of these are above 12" DBH. Most of the remaining large green trees are old wolf trees that appear to be nearly immune to bark beetle attack.

The bench above the Mud Lake area contains many patches of Douglas-fir. The area around Pacer Lake appeared representative of this Douglas-fir

timber. The data show 55 percent of the stand was killed. If the present epidemic condition had continued, nearly all of the large green trees would have been killed or infested by 1965. In addition, it is likely many of the stems below 12" DBH would have become infested.

Antimony Creek has several large stands of pure Douglas-fir type, all of which contained Douglas-fir beetle infestations. The bark beetle activity occurred in large groups scattered throughout the stands. Only about 34 percent of the trees were killed, however, over 89 percent of the trees 12" DBH or larger are dead.

In the Cottonwood area 68 percent of the Douglas-fir was killed between 1950-1963. Of the trees over 12" DBH, 94 percent are dead.

Powell District

On the Powell District there were three distinct situations in regard to the Douglas-fir beetle epidemics. On the west side of the East Fork of the Sevier River there were few infestations during the period 1950-1963. Most of the Douglas-fir on this side of the drainage occurs in mixed types. A post mortem of patches of Douglas-fir beetle killed trees in upper Kanab Creek and Robinson Canyon showed the bark beetle had killed trees in groups some thirty years ago. Scattered patches of Douglas-fir beetle activity did occur below the west rim of the Paunsaugunt Plateau, in 1950 through 1963, but the infestation did not spread to the Douglas-fir timber on the Plateau. On the east side of the East Fork of the Sevier River many scattered small groups of Douglas-fir were recently killed. The bark beetle was active along the steeper slopes immediately west of Bryce Canyon National Park for about ten years but the spots of infestation there never developed into aggressive type epidemics. No samples were taken on the Paunsaugunt Plateau, since most of the area is now under rather intensive management by the National Forest and National Park, and the problem is not now of a serious nature.

The picture on the north end of the Powell District was entirely different and corresponded to the serious problem on the Circleville District. In recent years epidemic populations of Douglas-fir beetle were active in nearly all patches or stands of Douglas-fir on that end of the District. Samples taken throughout these areas showed about 47 percent of the stems above 6" DBH had been killed. This was the only area where the beetle seemed to prefer trees under 12" DBH. However, only 16.7 percent of the remaining green trees were above 12" DBH. The average size of the green timber remaining is 13" and the trees are two logs in height. Most of the Douglas-fir occurs in small patches on the north faces of steep slopes. Nearly all of these patches are currently inaccessible.

Panguitch Lake District

Most of the pure stands of Douglas-fir on the Panguitch Lake District harbored active epidemic populations of the Douglas-fir beetle during the recent outbreak. One of the most persistent infestations was located at

the head of Indian Hollow and extended around Five Mile Bench. Here 81 percent of the Douglas-fir was killed, and 90 percent of the larger trees succumbed. In a newer infestation on the west side of Indian Hollow, 66 percent of the timber stand was destroyed.

In the Bear Valley--Red Creek areas the Douglas-fir beetle epidemic increased steadily for about seven or eight years, but in 1961 and 1962 explosive buildups occurred. In Red Creek the 1963 data showed nearly 100 percent of the trees above 12" DBH had been killed or were infested. Thirty-five trees per acre over 12" DBH were infested in 1963. In Bear Valley the Douglas-fir stands extend along the northwest facing slopes. Only 35 percent of the total stems were destroyed but 93 percent of the larger trees were dead.

Cedar City District

The south end of the Cedar City District has in recent years remained relatively free of Douglas-fir beetle activity. There are a few small groups of dead trees in upper Swain's Creek. These were located in small patches of Douglas-fir interspaced in the ponderosa pine stand. The situation did not develop into a serious infestation. It was planned to sell the more susceptible timber in upper Strawberry and Swain's Creek.

The Douglas-fir beetle was severely epidemic in and around the west side of Cedar Breaks National Monument. Large groups of dead trees are noticeable, particularly around Blowhard Mountain and at the bottom of Cedar Breaks. The Douglas-fir stands around Yankee Meadows and north to Hoosier Lake were infested from 1950 through 1963. These infestations were comparable to the Bear Valley infestations in numbers of trees lost.

Escalante District

Heavy concentrations of dead trees resulting from recent epidemics of the Douglas-fir beetle occur along the breaks of Table Cliff Plateau and Aquarius Plateau. Many infestation centers were located around Canaan Mountain also. The infestation pattern and timber destruction in these areas was similar to that which occurred on the Circleville District on the west side of the Aquarius Plateau. Here again most of the Douglas-fir timber is inaccessible, and the number of green trees over 12" DBH probably averaged fewer than 15 per acre.

A large timber sale in the Canaan Mountain area was scheduled to remove most of the merchantable Douglas-fir on the Mountain.

The John Allen sale, while principally in pine, removed Douglas-fir from one infested area. Just below John Allen Bottom in Hungry Creek a small permit sale was let four years ago to salvage dead Douglas-fir.

Recently, because of a local demand for Douglas-fir, the Pine Creek area was scouted to find suitable areas to log. No areas containing sufficient

volume to be merchantable were found. Most of the patches of Douglas-fir had been seriously depleted by infestations of the Douglas-fir beetle.

Teasdale District

Many small stands of Douglas-fir are situated below the rim on the north and west side of Boulder Mountain. The Douglas-fir beetle has been active in all of these stands. Most of the Douglas-fir on the north side is inaccessible. The recent infestations were extremely aggressive. They appeared as many small "hot spots," most of which would not exceed an acre in size.

On the west side Douglas-fir stands are found from just north of Government Point south to Dark Valley, covering nearly 10,000 acres. Extensive tree killing has taken place and the recent epidemic was very virulent throughout these stands.

A five MM bd. ft. sale covering much of this area was advertised and sold in 1963. Not much cutting has been done to date, however, this sale should do much to utilize the remaining green merchantable Douglas-fir trees and sound dead timber in this area. Slash will be disposed of in a manner that will minimize bark beetle buildup.

In addition to the areas already mentioned, the Douglas-fir beetle was also epidemic in Draw Valley and the east side of Upper Logging Grove.

RECOMMENDATIONS

It is obvious that until the Dixie National Forest Douglas-fir stands are made accessible little can be done to eliminate the accelerated loss of timber. Therefore, it would seem the first objective should be to establish a road net into the Douglas-fir stands.

In addition, the Forest Service should work towards encouraging the sale and use of Douglas-fir on the Dixie National Forest. The Dixie personnel have made good progress but more needs to be done. Wherever possible logging should first be directed toward the higher value stands such as these at the heads of the East Fork of Sevier, Strawberry, and Swain's Creek to minimize the possibility of the Douglas-fir beetle becoming epidemic later in these areas. Dead and green material in the areas recently infested should be logged as soon as possible to reduce the loss of merchantable volume through deterioration.

Whenever logging is undertaken in Douglas-fir stands provision should be made for the disposal of large diameter slash. Green trees felled after July 1, and the slash therefrom, can usually be left on the ground until the following June to catch adult beetles in flight, but must be disposed of that fall to prevent the beetles from emerging early the next spring. Trees felled in the early spring before July 1 should be removed and the slash burned the fall or winter of the same year.

Chemical control is extremely costly and it is not likely that such treatment will be justifiable except in special cases whose highly used campgrounds or other areas of high value must be protected. It should be recognized, however, that reduction of the beetle population through chemical treatment will not eliminate the likelihood of the bark beetles again increasing to epidemic levels in the same locality. The best protective measure, therefore, is the establishment of cultural practices that will encourage the establishment of healthy, thrifty Douglas-fir stands. This should be the long-range management objective for all Douglas-fir stands, regardless of the location.

Windthrown or severely wind-damaged trees should be reported promptly to the Regional Office so an entomologist can be scheduled to inspect the area for possible Douglas-fir bark beetle buildup. Likewise, any new outbreaks of the Douglas-fir beetle should be reported promptly to the Regional Office.

SUMMARY

It is estimated nearly 90 percent of the Douglas-fir type on the Powell Division has in recent years contained active infestations of the Douglas-fir beetle. The only sizable patches of Douglas-fir free of recent bark beetle activity are found in the mixed stands at the head of the East Fork of the Sevier River.

Using an average figure of 100 bd. ft. per tree above 12" DBH, the loss in the last ten years on the Powell Division has exceeded 100 million bd. ft. of merchantable size Douglas-fir. In addition, many thousands of trees under 12" DBH have been killed.

On the Dixie Division only about half of the Douglas-fir stands were subjected to recent epidemic infestations of the Douglas-fir bark beetle. However, in the infested areas approximately 90 percent of the trees over 12" DBH have been destroyed.

APPENDIX

Supplementary Information

Table 1.---Sample Tree Measurements - Dixie N. F.[1/]

Location	Tree No.	Age[2/]	DBH (in.)	Tree Ht. (ft.)	Dia. at Top of Infested Length (in.)	Infested Length (ft.)
Barney Top	1	202	15.4	60	13.5	18
	2	205	17.3	66	12.9	28
(T32S, R1W,	3	212	16.0	62	13.5	19
Sec. 27)	4	209	17.4	70	13.0	34
Elev. Approx.	5	189	17.6	60	14.9	18
9,000'	6	211	15.9	59	11.0	27
	7	231	16.5	53	14.8	16
	8	243	16.3	53	14.1	19
	9	218	14.4	57	12.8	14
	10	239	21.0	59	18.2	16
Average		216	16.8	60	13.9	21
Little Valley	11	243	20.4	61	12.1	32
	12	122	11.2	50	9.2	20
(T34S, R7W,	13	108	11.4	49	9.6	14
Sec. 36)	14	123	11.7	44	8.7	21
Elev. Approx.	15	139	13.1	53	10.9	21
7,000'	16	129	10.6	51	9.0	18
	17	297	20.3	50	13.0	29
	18	301	18.1	54	11.7	29
	19	166	13.8	45	9.2	27
	20	152	11.9	49	10.3	16
Average		178	14.2	51	10.4	23
Average		197	15.5	55	12.1	22

1/ These data supplied by Mal Furniss of the Intermountain Forest and Range Experiment Station.

2/ Number of rings at stump height. Estimated number of years to stump height = 7.

Figure 1. Mixed stand of timber with Douglas-fir volume seriously depleted by Douglas-fir beetles. Loggable area.(Head of Sweetwater Creek).

Otto Sandin

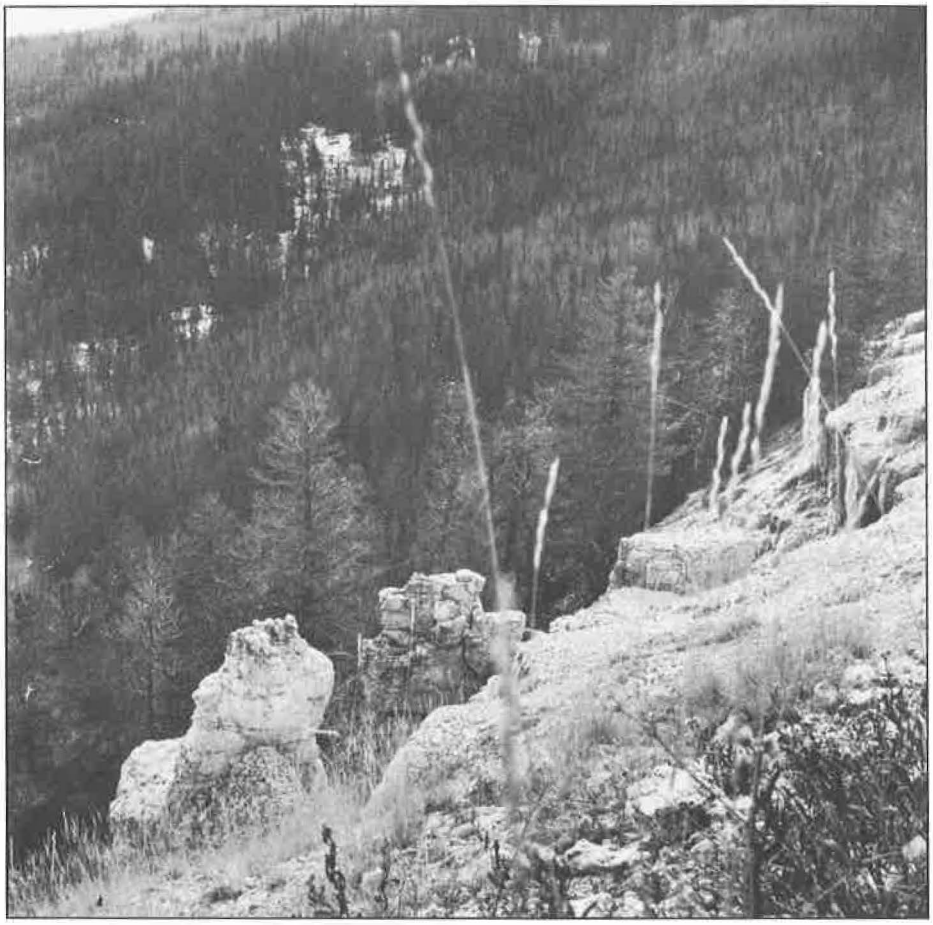

Figure 2. Extensive killing by the Douglas-fir beetle. Steep rocky slope immediately above Horse Creek logging area.

Figure 3. Moderate tree mortality caused by Douglas-fir beetle. Within Travel Influence Zone, Escalante Summit, above Widstoe, Utah.

Figure 4. Horse Creek timber sale area. Susceptible and dead Douglas-fir trees removed. (Slash disposal and erosion control work not completed.)

Figure 5. Douglas-fir stand extending to edge of high altitude meadow. Douglas-fir beetles usually do not buildup on the fringes, but can be expected to develop in the larger trees within the stand.

Figure 6. Mature loggable Douglas-fir stand. Road is rough, narrow, steep and unsuitable for logging trucks. Barney Top.

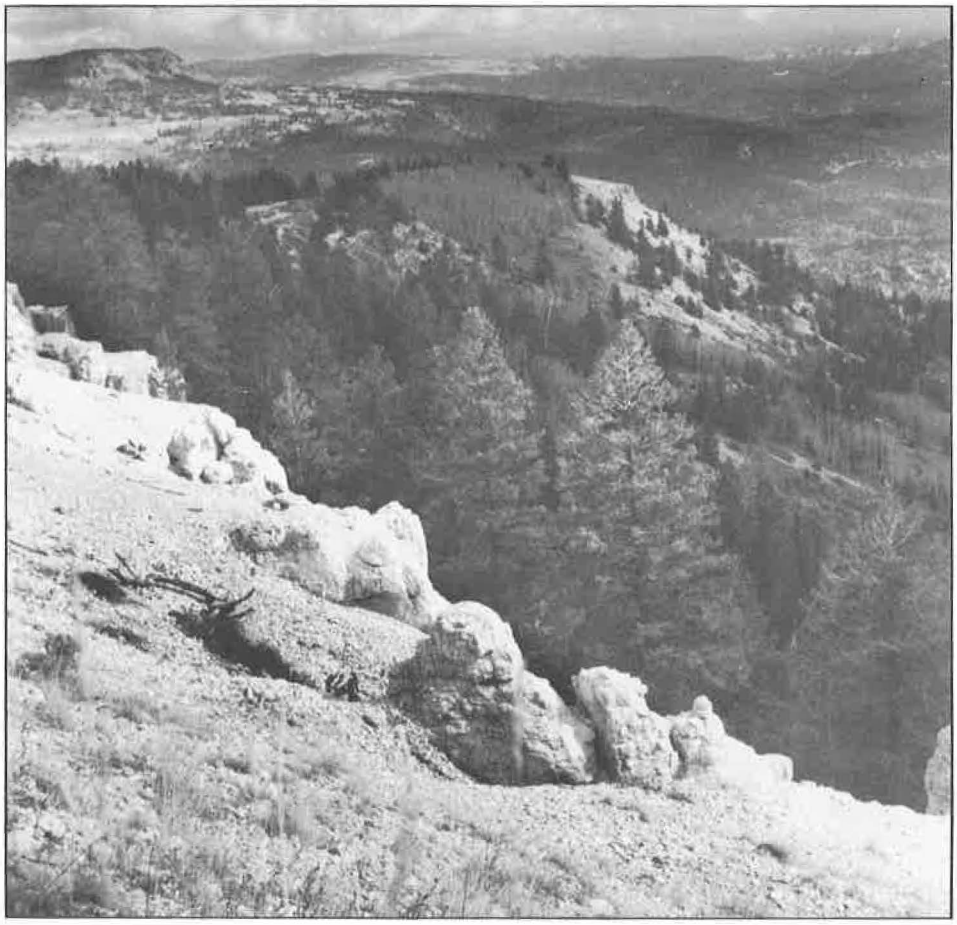

Figure 7. Steep, rocky, unloggable area. East slope of Aquarius Plateau. Bark beetle damage moderate.

Figure 8. Typical undamaged Douglas-fir stand. Water Influence Zone. (West end of Navajo Lake). Such stands are in the minority on the Dixie National Forest now.